

# Glacier-Change Mapping in the Lake Clark National Park and Preserve

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# Acknowledgments

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NASA - Goddard Space Flight Center

Cyospheric Sciences Branch

# Alaska Glaciers

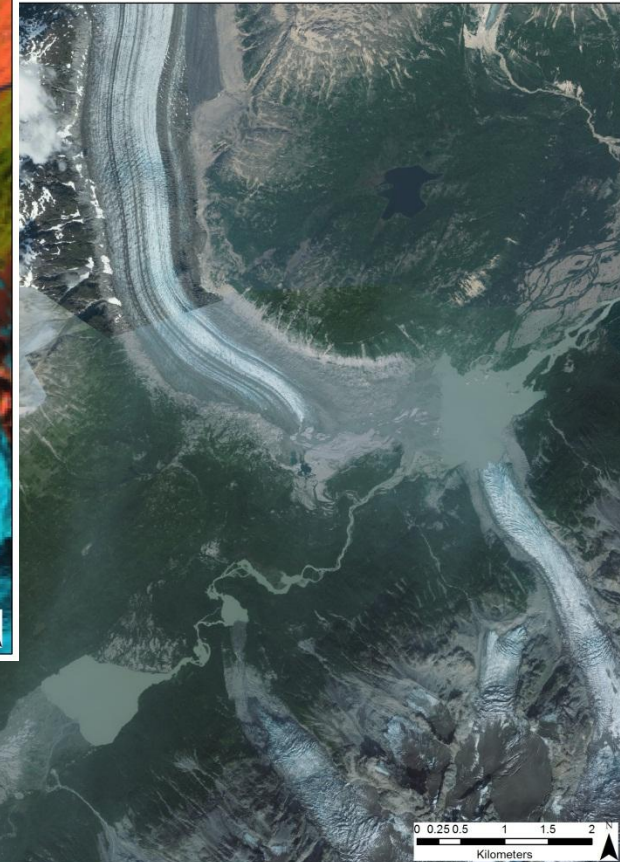
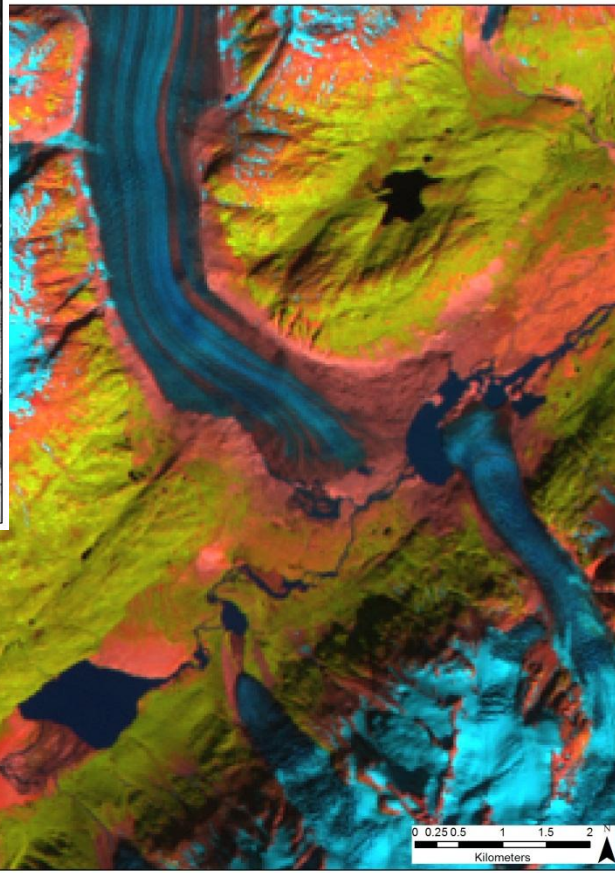
- Glaciers have generally been shrinking, some dramatically
- From the mid-1990s to 2001, Alaska glaciers have shown accelerated thinning compared to the period from 1950-1990 (Arendt et al., 2009)





# Glacier Change at Lake Clark Pass

**Ikonos  
~2007**



**Landsat  
1987**

**USGS Black and White  
1954**

# Outline

- Why?
- Objectives
- Methodology
- Key findings
- Issues and limitations
- Future plans

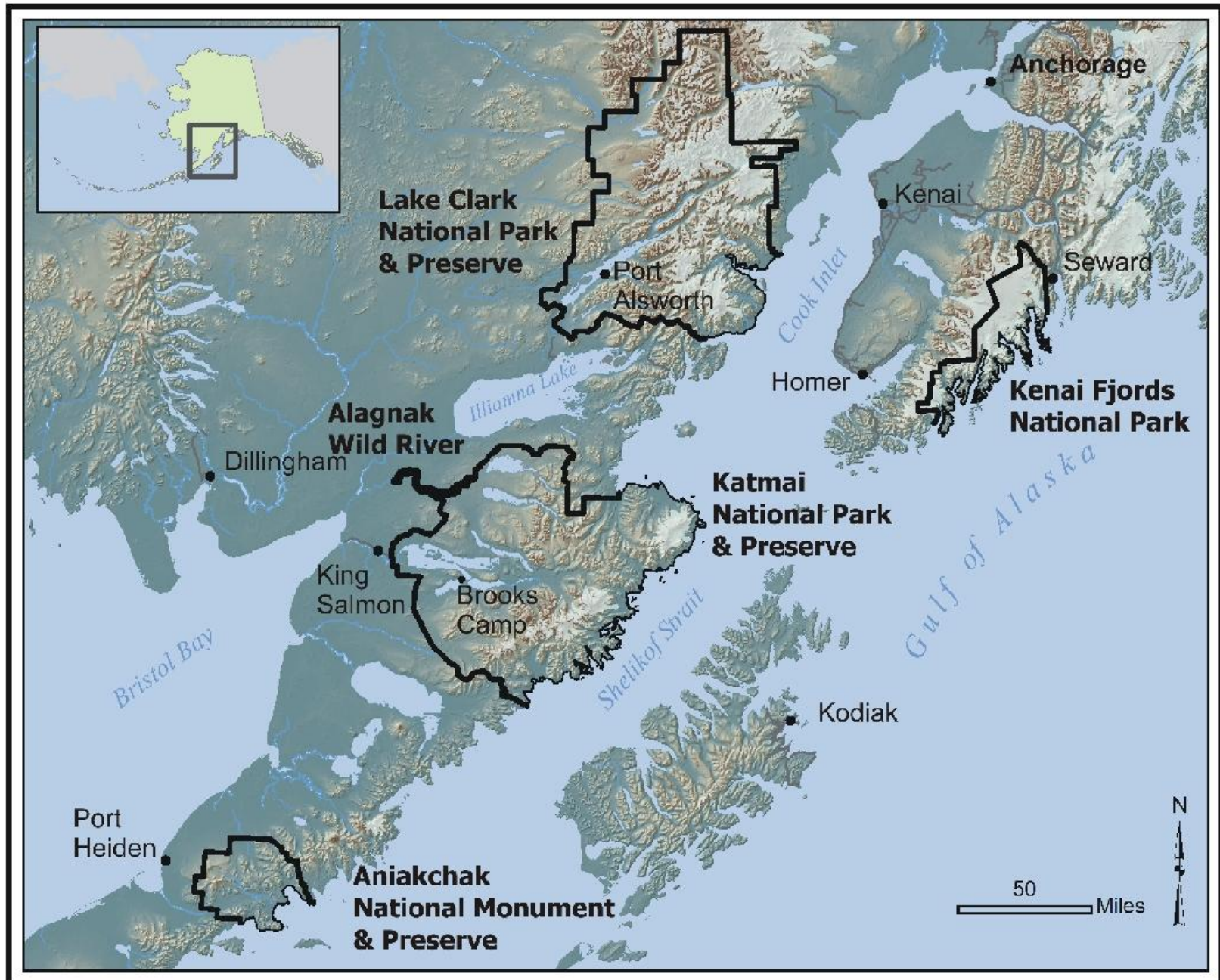
# Why

- Significant landscape feature in the SWAN parks
- Changes to this land cover type will affect both terrestrial and aquatic ecosystems in the SWAN

## Objectives

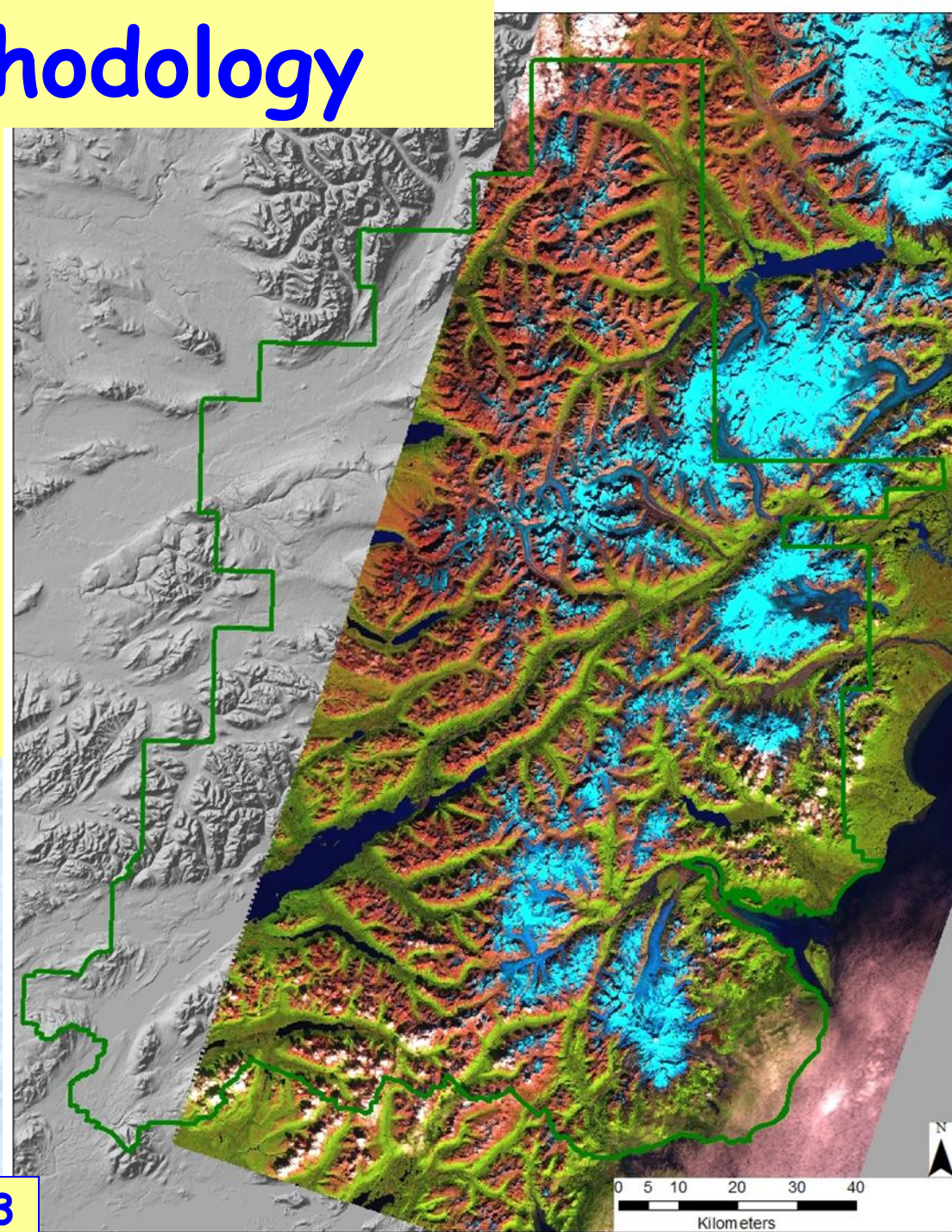
- The objective is to map glacier extent, on a decadal scale, park-wide in Lake Clark NP&P using Landsat satellite imagery (early 1970s-present)
- GIS will be used to analyze change between these decadal spaced mapping efforts
- Shapefiles will be provided to the Global Land Ice Measurements from Space program (GLIMS)  
<http://www.glims.org/>

# Southwest Alaska Network



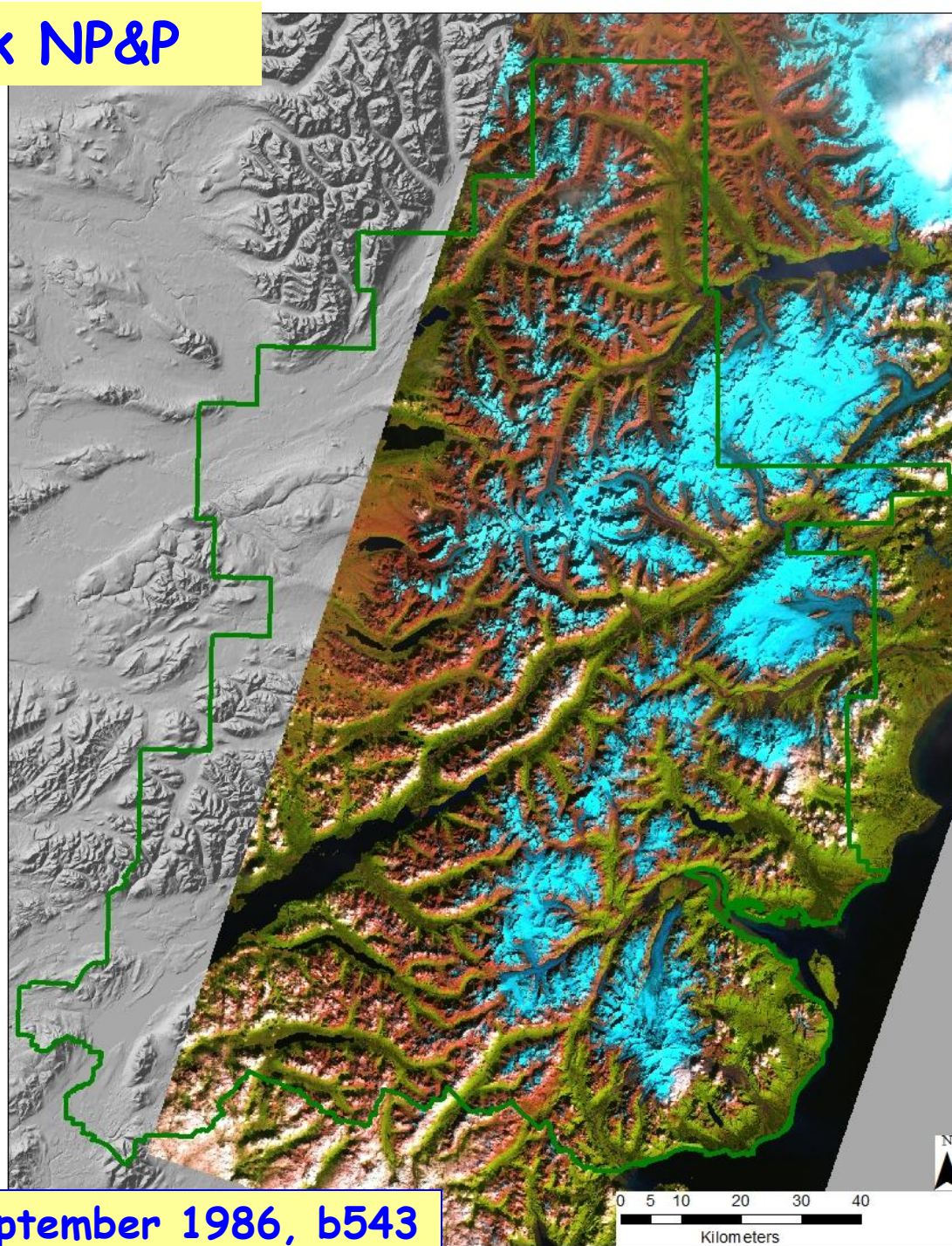
# General Methodology

- Acquire late-season, cloud-free Landsat imagery
- Classify imagery for snow and ice
  - ☐ Band ratio techniques
  - ☐ Apply threshold value
  - ☐ Export resultant classification to shapefiles
- Edit shapefiles for areas of misclassification



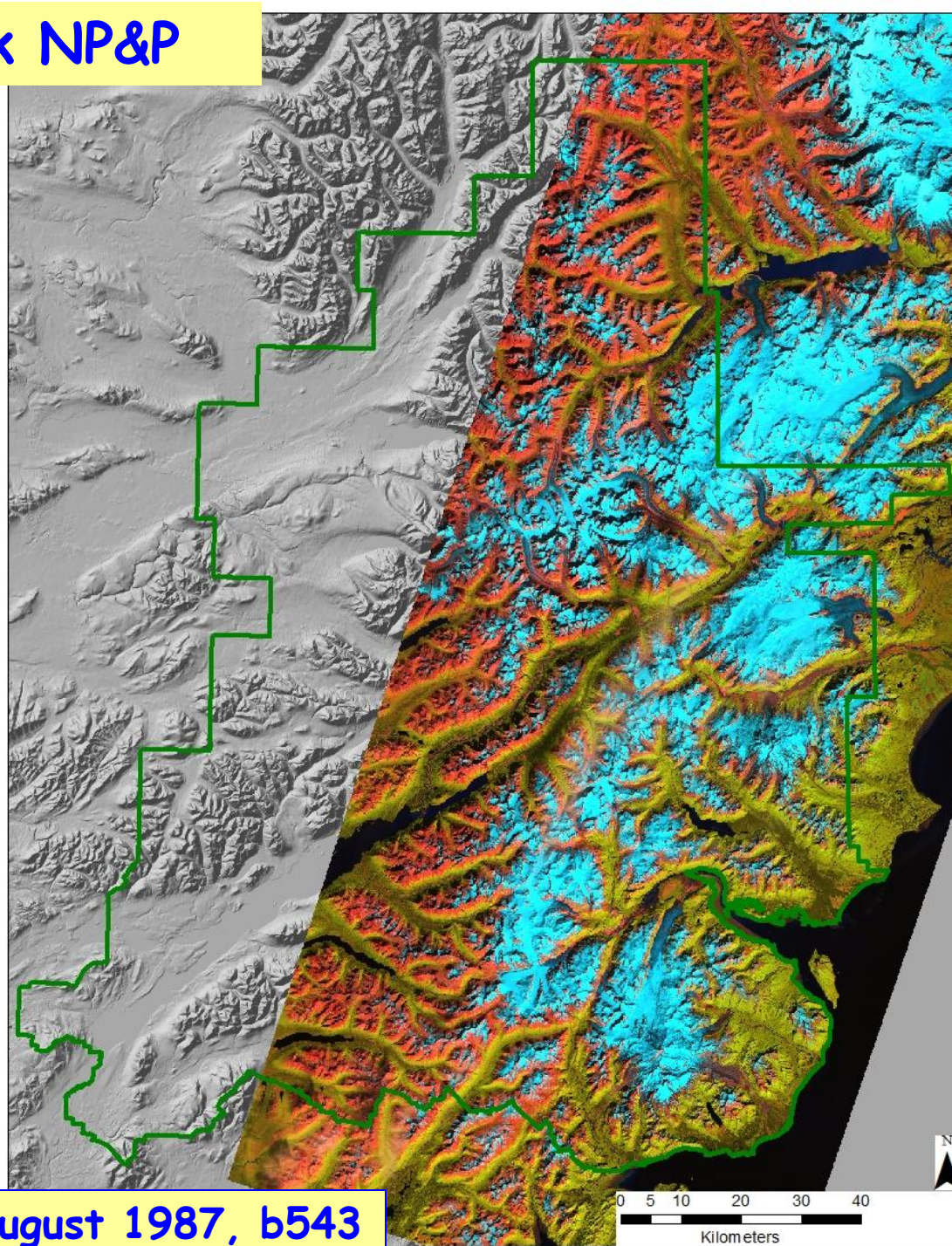
Landsat 5, 28 August 2007, b543

# Lake Clark NP&P



Landsat 5, 3 September 1986, b543

# Lake Clark NP&P

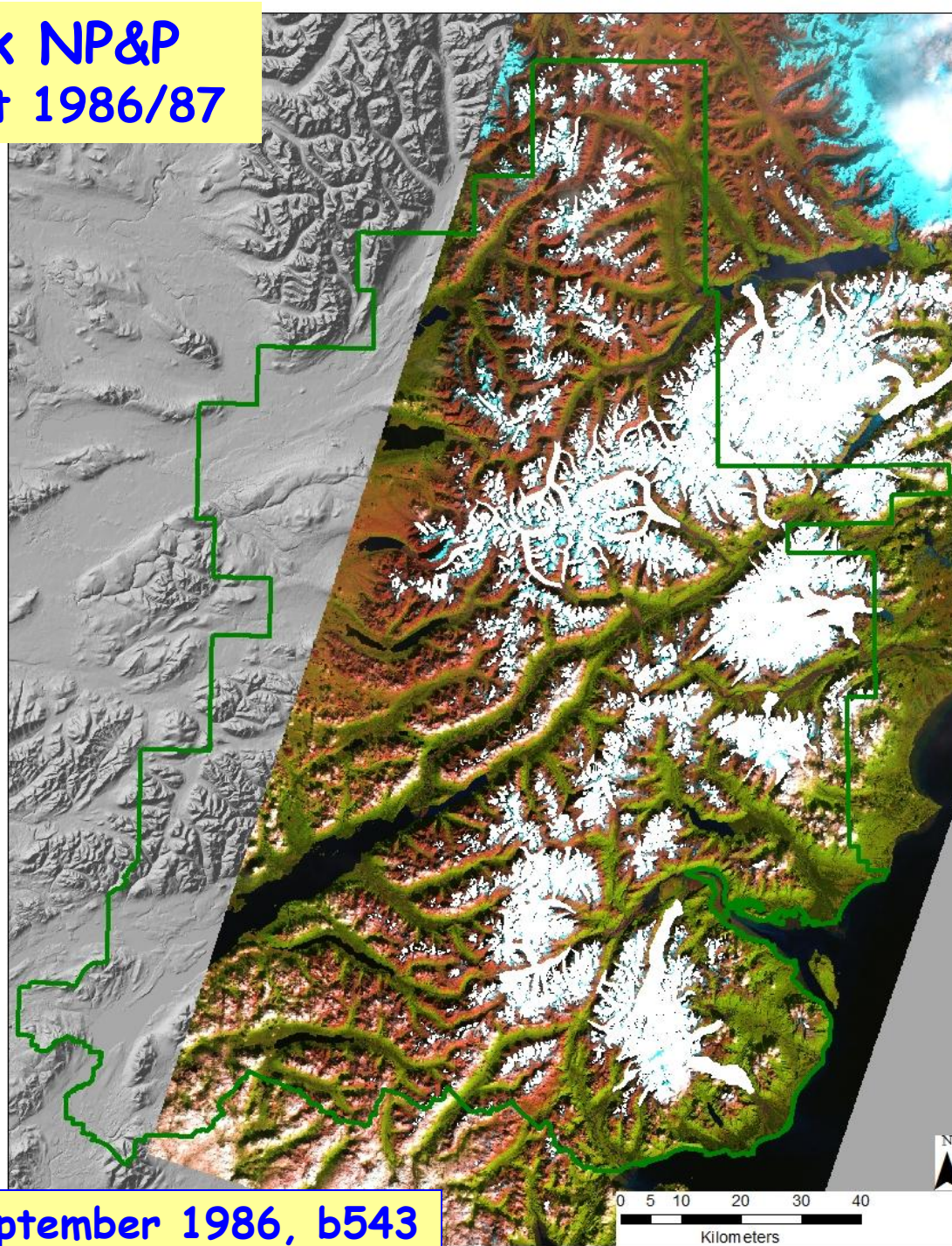


Landsat 5, 21 August 1987, b543

# Lake Clark NP&P

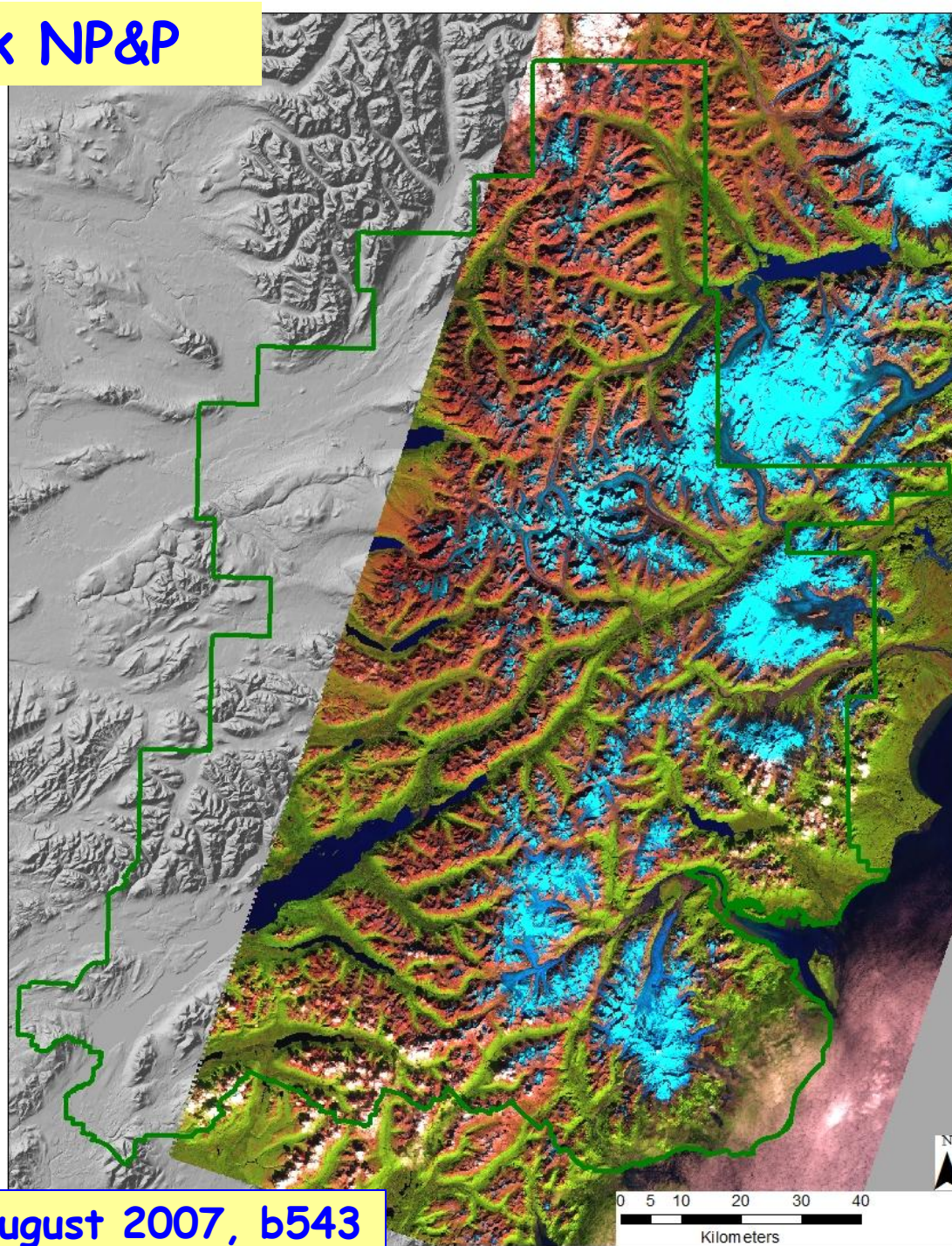
## Glacier Extent 1986/87

**1986/87**  
2,741 sq km  
(677,365 acres)



**Landsat 5, 3 September 1986, b543**

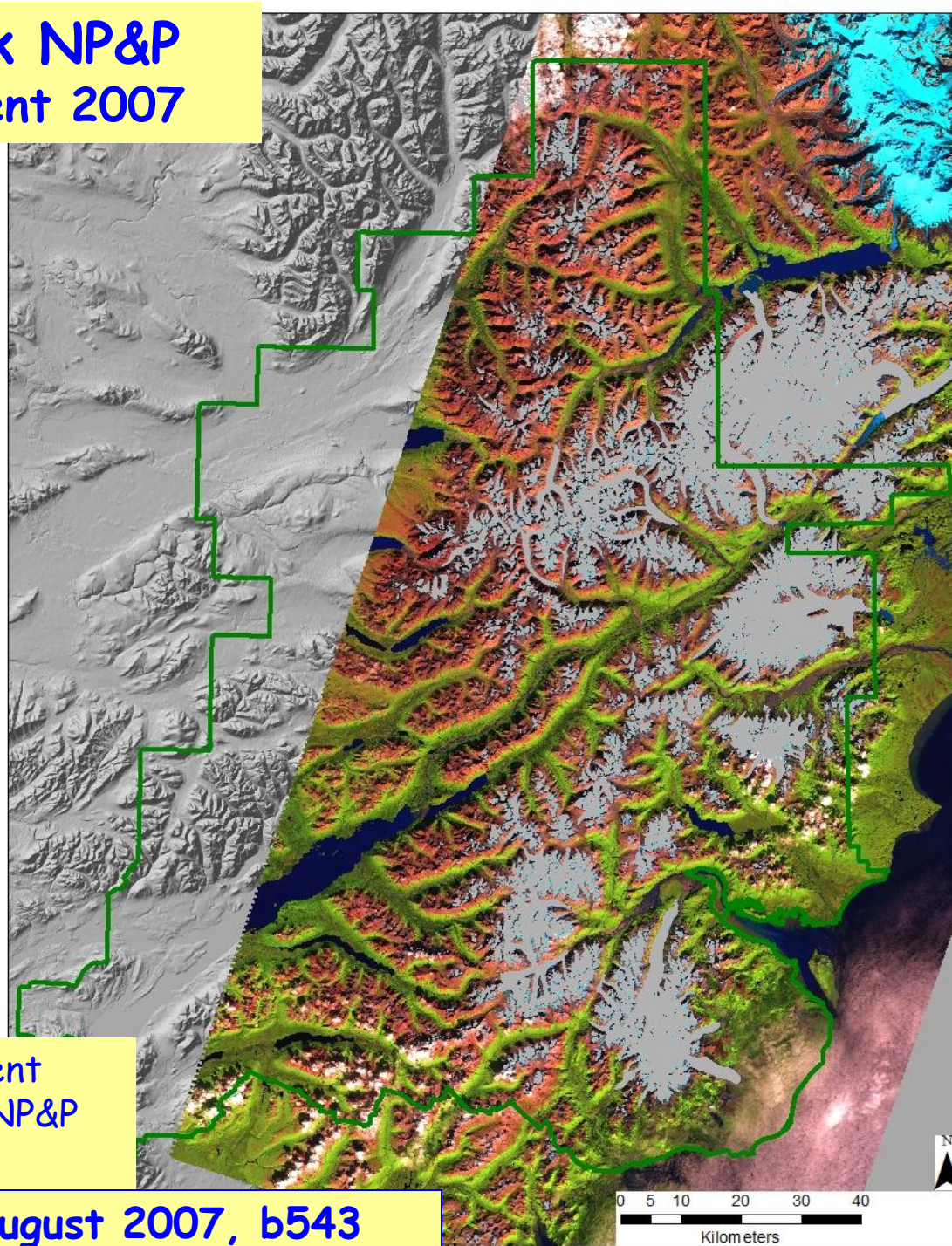
# Lake Clark NP&P



Landsat 5, 28 August 2007, b543

# Lake Clark NP&P Glacier Extent 2007

**2007\***  
2177 sq km  
(538,170 acres)



\* 2007 glacier extent  
data in Lake Clark NP&P  
by GLIMS

Landsat 5, 28 August 2007, b543

# Lake Clark NP&P

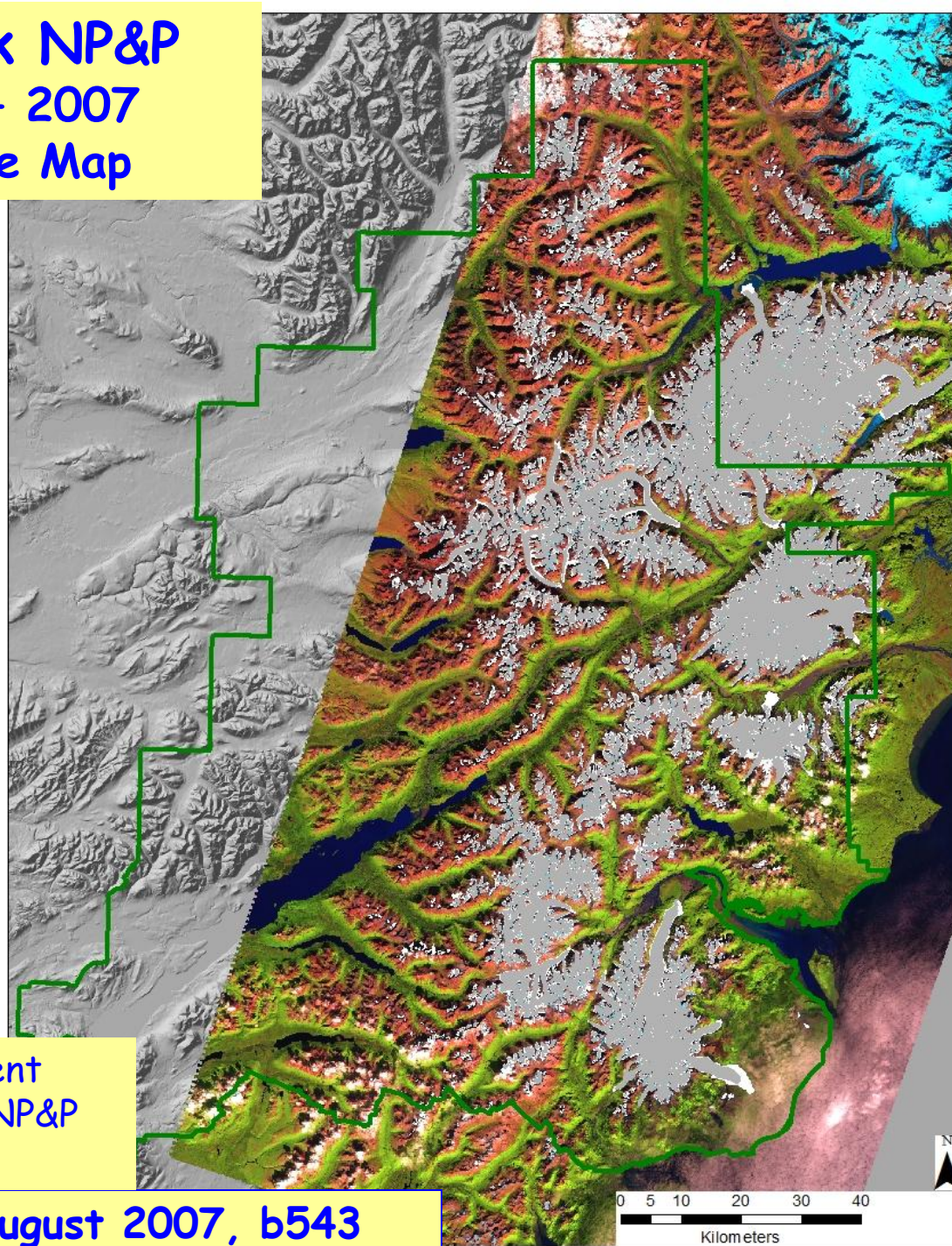
## 1986/87 - 2007

### Difference Map

1986/87

2007

**Difference**  
-564 sq km  
(-139,367 acres)

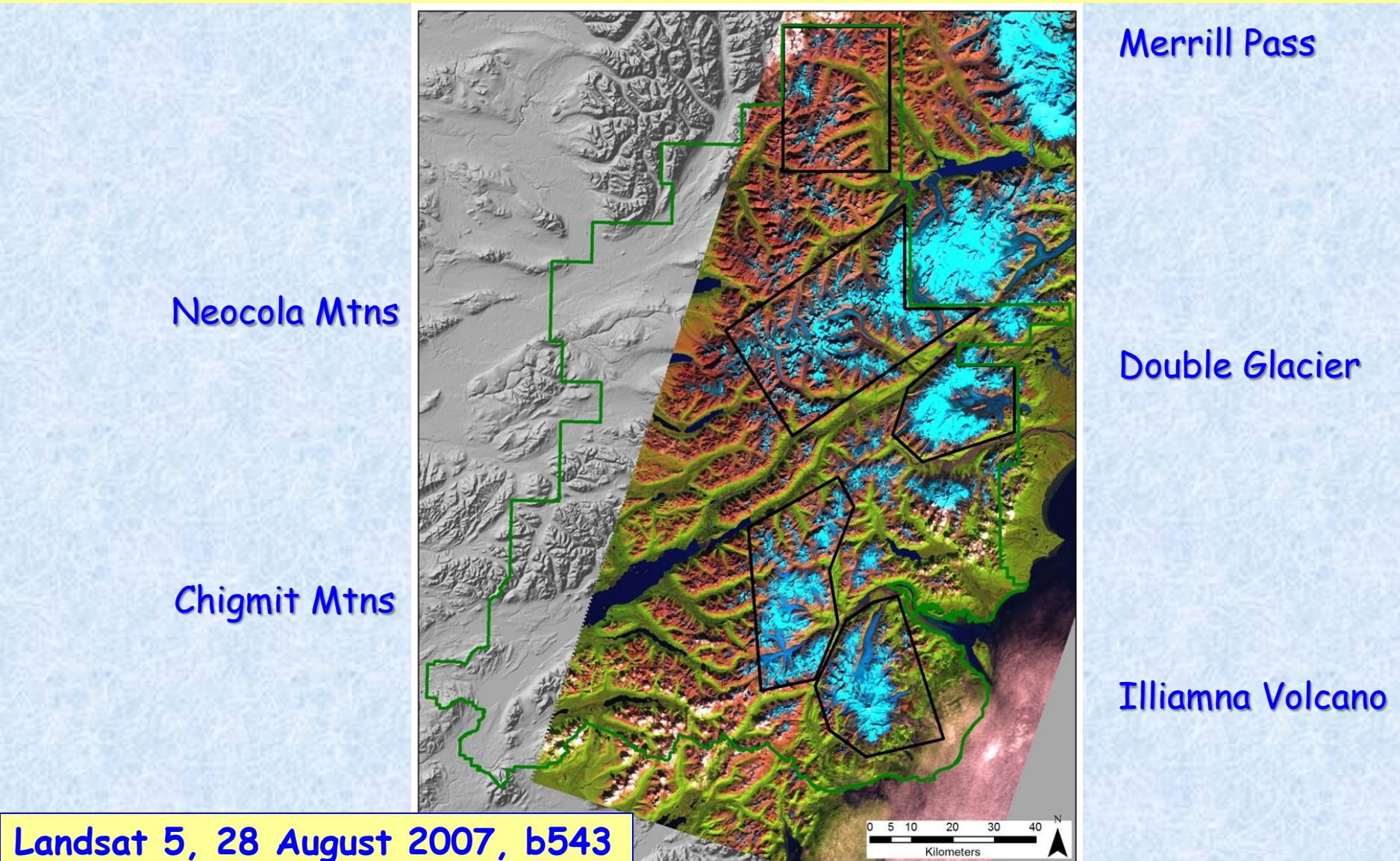


\* 2007 glacier extent  
data in Lake Clark NP&P  
by GLIMS

Landsat 5, 28 August 2007, b543

# Summary of Glacier Extent Mapping

## Lake Clark NP&P



# Summary of Glacier Extent Mapping

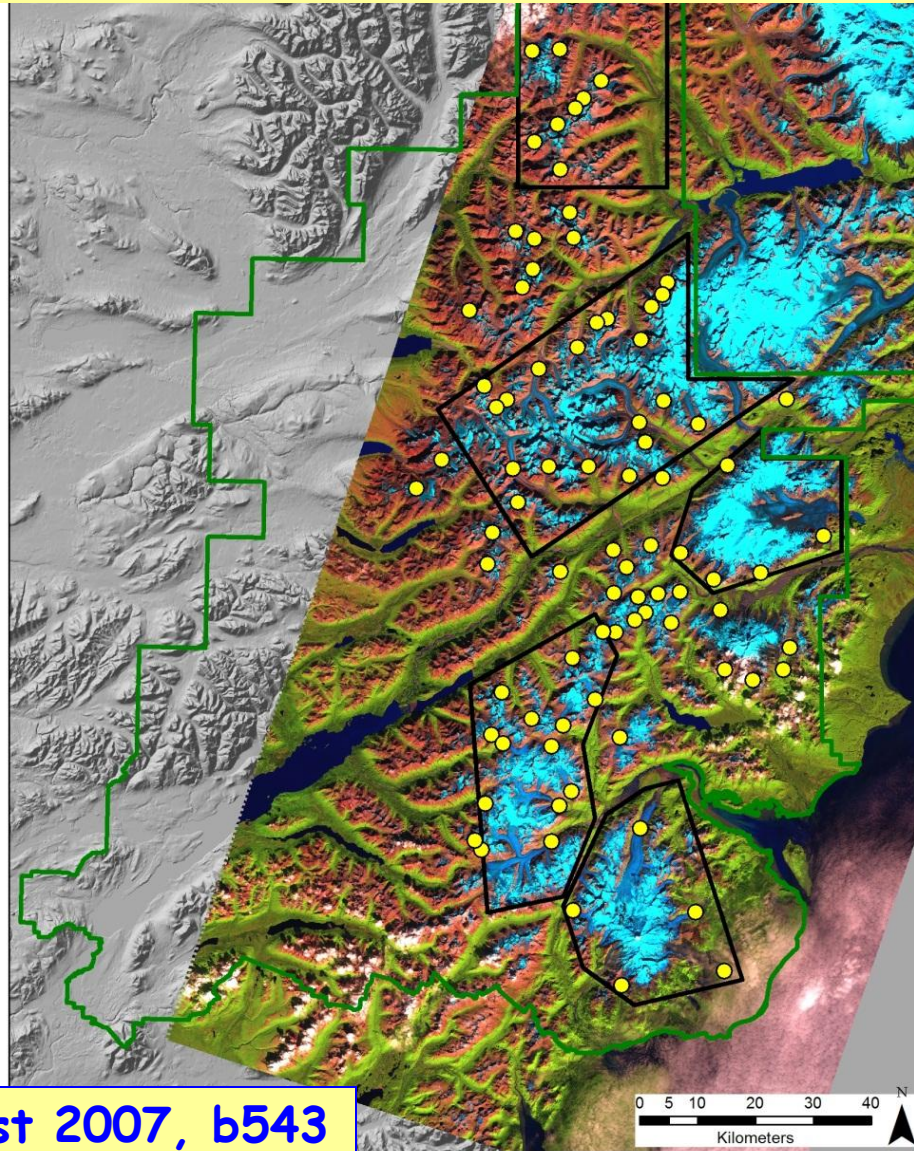
## Lake Clark NP&P

	1986/87 (km2)	2007 (km2)*	Change (km2)	% Change
Park-wide	2741	2177	-564	-21%
Merrill Pass Region	151	89	-62	-41%
Neocola Mountains Region	752	622	-130	-17%
Double Glacier Region	368	341	-27	-7%
Illiamna Volcano Region	351	310	-41	-12%
Chigmit Mountains Region	516	401	-115	-22%

\* 2007 glacier extent data in Lake Clark NP&P by GLIMS

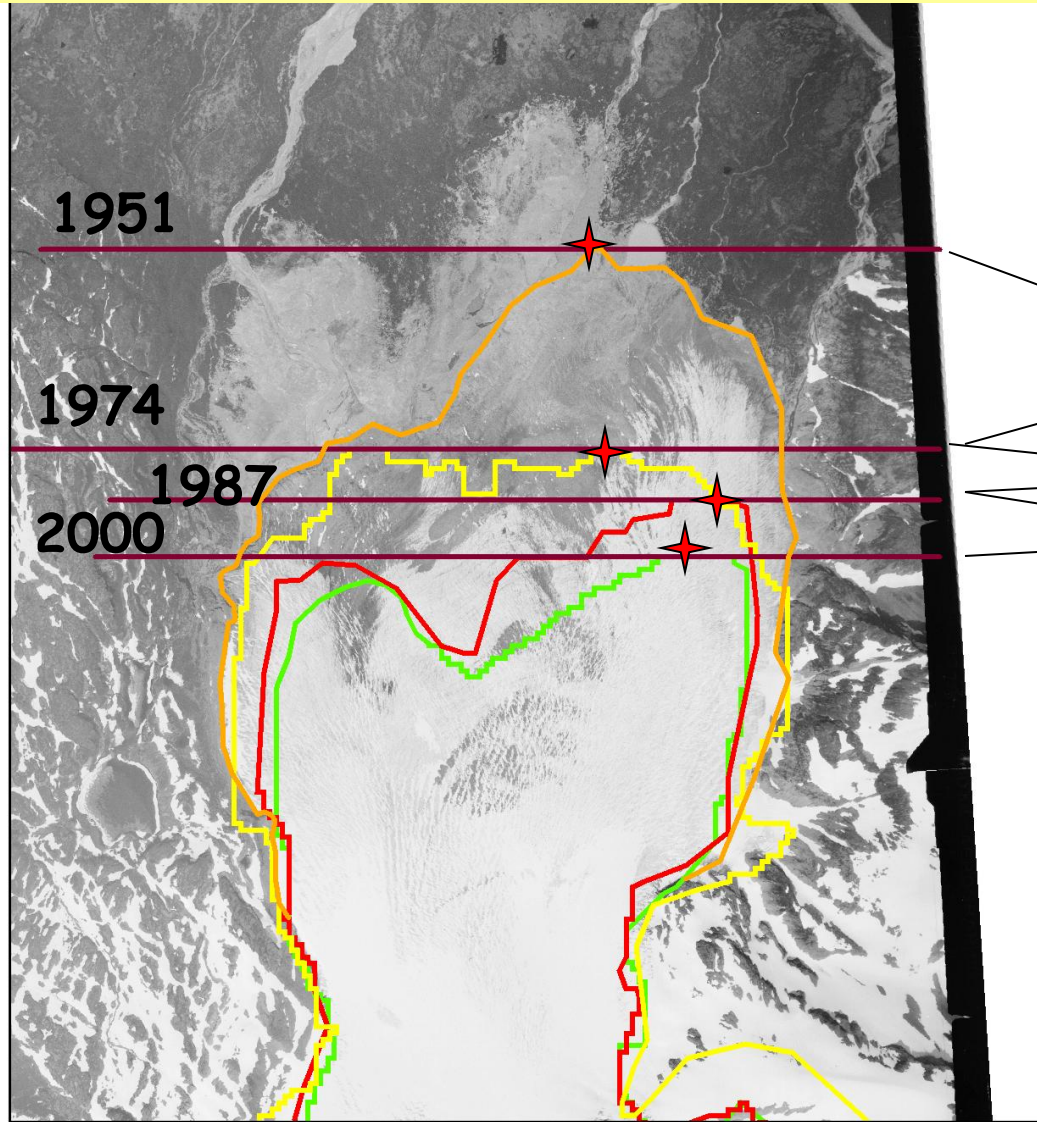
# Summary of Glacier Terminus Change

## Lake Clark NP&P



Landsat 5, 28 August 2007, b543

# Measuring Glacier Terminus Change



0 0.5 1 1.5 2  
Kilometers



-944 m (1951 to 1974)

-242 m (1974 to 1987)

-266 m (1987 to 2000)

-1452 m (1951 to 2000)

Measurements based on  
furthest down-valley  
extent of the glacier

# Summary of Glacier Terminus Change

## Lake Clark NP&P

	Mean change (m) from 1955-2007; Second number is mean annual rate of change (m/yr)		Mean change (m) from 1955-1986; Second number is mean annual rate of change (m/yr)		Mean change (m) from 1986-2007; Second number is mean annual rate of change (m/yr)		Number of Glaciers Measured
All	-1092	-21	-602	-19	-490	-23	87
Merrill Pass Region	-818	-16	-470	-15	-347	-17	9
Neocola Mountains Region	-1395	-27	-754	-24	-642	-31	22
Double Glacier Region	-1097	-21	-757	-24	-340	-16	5
Illiamna Volcano Region	-1296	-25	-759	-24	-538	-26	6
Chigmit Mountains Region	-1000	-19	-515	-17	-484	-23	22

# Issues and Limitations

Most important issues that affect our ability to map glacier margins (including termini) accurately from space are:

- ✓ Debris cover can mask the glacier terminus especially in the case of retreating glaciers
- ✓ Fresh snow cover
- ✓ Lingering snowpack
- ✓ Shadows
- ✓ Clouds

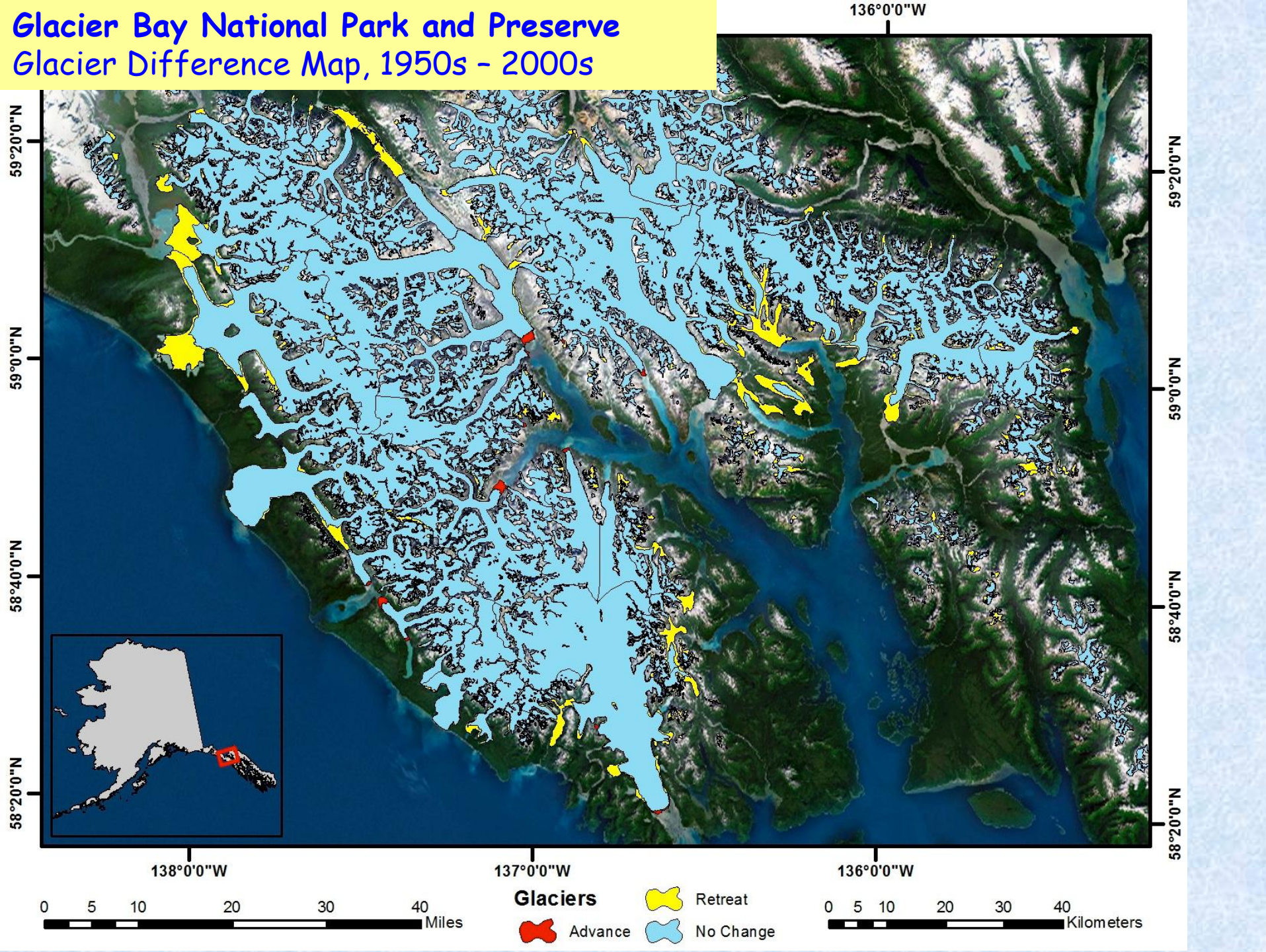
# Future Work

## Alaska NPS Glacier Inventory and Change Assessment

- Glacier Extent Mapping for two time period (1950s and present)
  - - PI: Dr. Anthony Arendt, UAF
- Glacier Volume Change Analysis (based on NED and repeat Laser altimetry)
  - - PI: Dr. Chris Larsen, UAF
- Data Analysis, Focus Glaciers and Report Writing
  - - PI: Dr. Michael Loso, APU

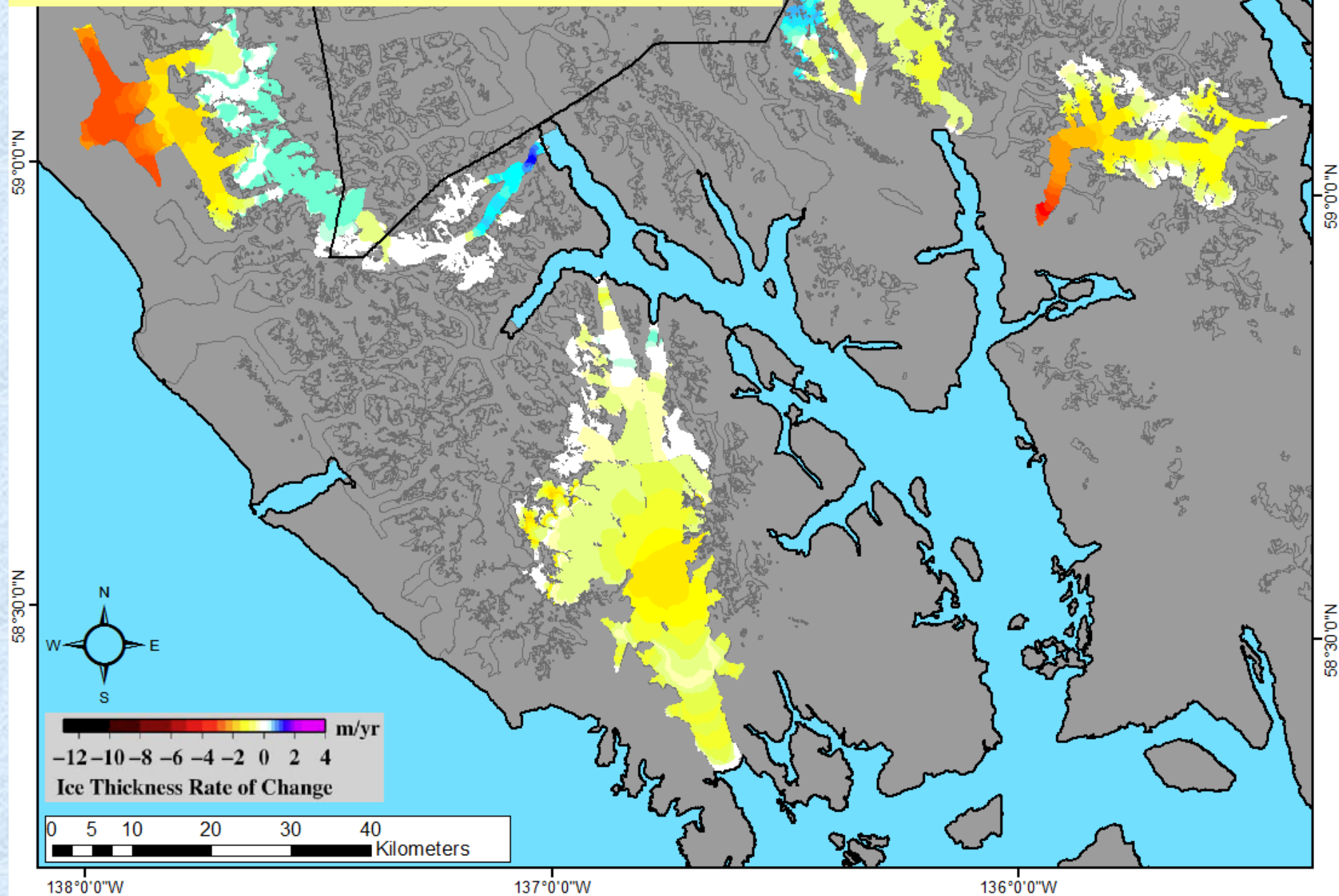
# Glacier Bay National Park and Preserve

## Glacier Difference Map, 1950s - 2000s



# Glacier Bay National Park and Preserve

## Annual rate of ice thickness change for selected glaciers, 2005-2009





Thanks for listening.

Questions?

Acknowledgements

Dorothy Hall, NASA,  
Goddard Space Flight Center  
Cryospheric Sciences Branch

GLIMS Glacier Database.  
Boulder, Colorado USA

<<http://www.glims.org/>>